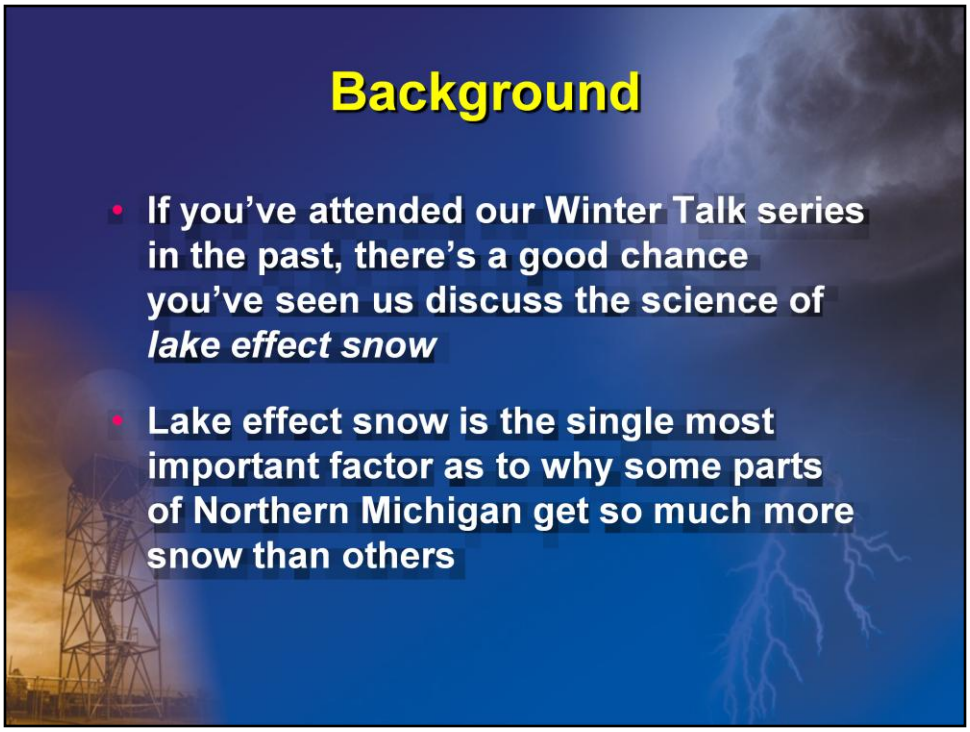
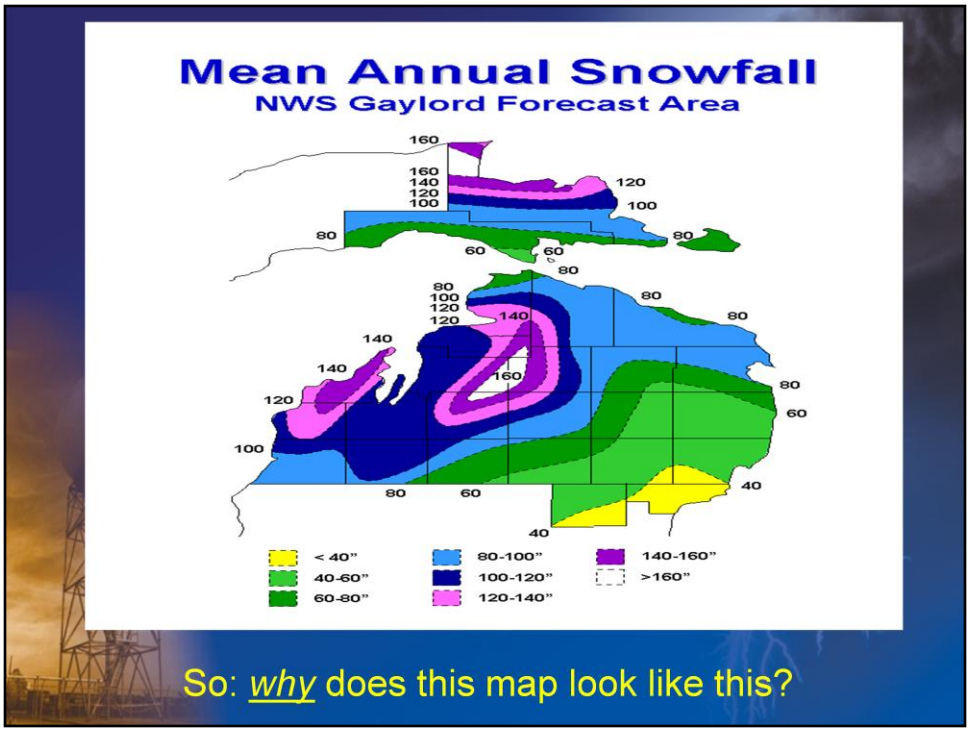
Explaining Northern Michigan Snow

(A "Big Picture" Viewpoint)

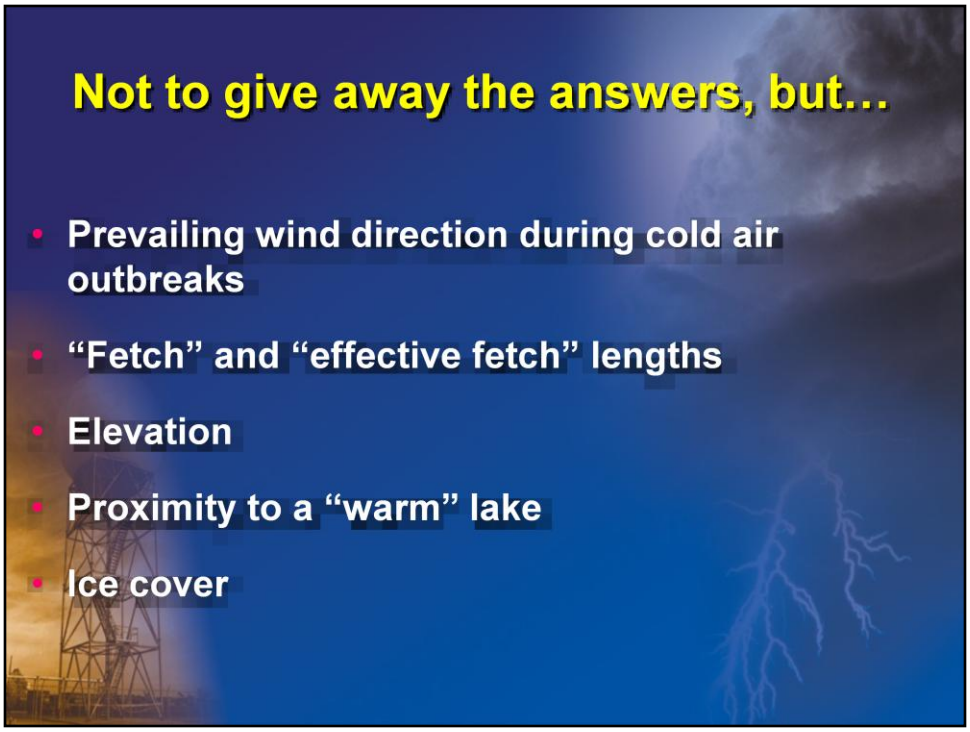
2010 Winter Talk Series



We won't rehash those previous talks TOO much, but we will talk about some of the same topics from a somewhat different angle.



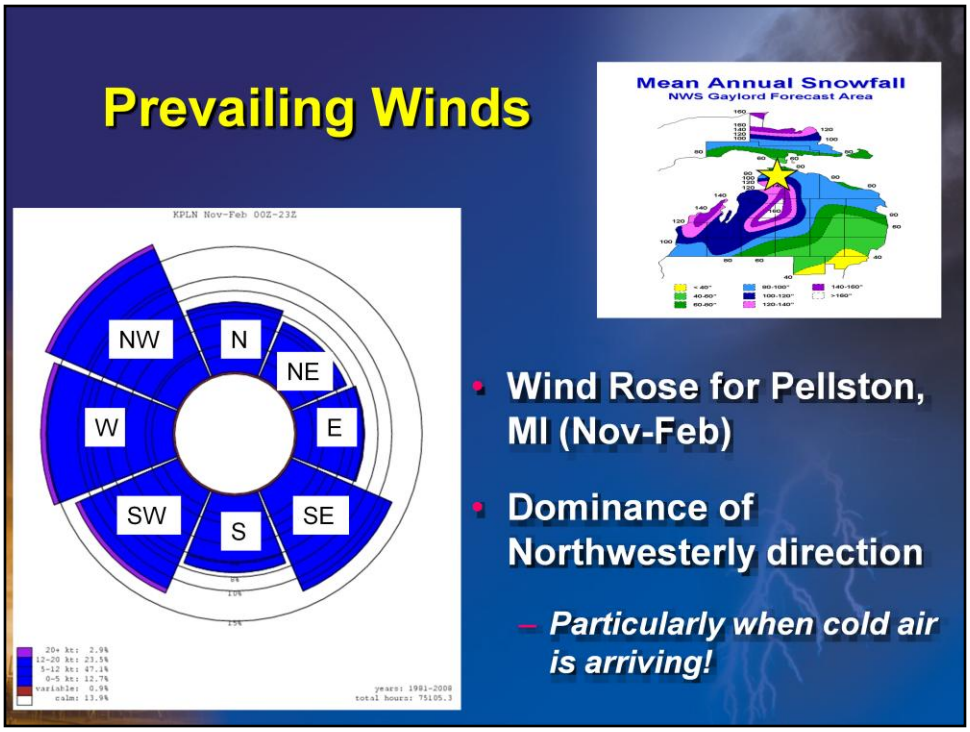
In this presentation we will try to answer why our mean annual snowfall map has the pattern it does.



Here are some of the reasons that we will examine throughout this presentation.

Prevailing Winds

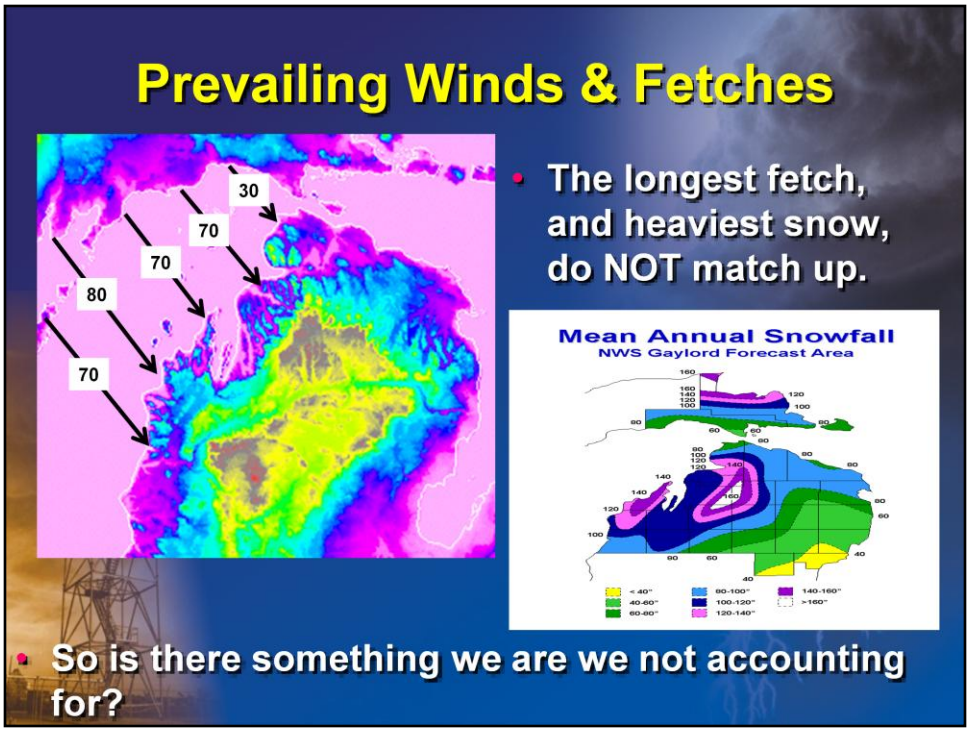
- Lake effect snow will tend to develop over the Great Lakes, as long as the air is cold enough, and the water is warm enough
- Where the snow goes from there, depends on where the wind is blowing
- Thus, the "prevailing wind" – our most common wind direction – during periods of cold weather is crucial



The plot on the left shows a wind rose of all wind reports from Pellston for the November-February period. You can see that, for a majority of the time, the prevailing winds are West or Northwesterly, particularly when cold air is arriving.

Prevailing Winds & Fetches

- A “fetch” is the distance over which air is moving over water, for a given wind direction
  - *Generally speaking, the longer the fetch, the more snow the lake will be capable of generating*
- Given that a northwest wind is our prevailing winter wind, what kind of fetch does that produce?

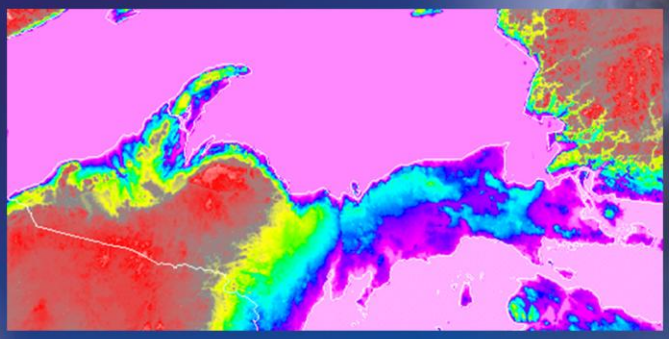


The figure on the left shows the fetch for a northwesterly wind over northern Lake Michigan. However, if you look at the mean annual snowfall map, the longest fetches do not always match the areas that receive the most snowfall. Why is that?

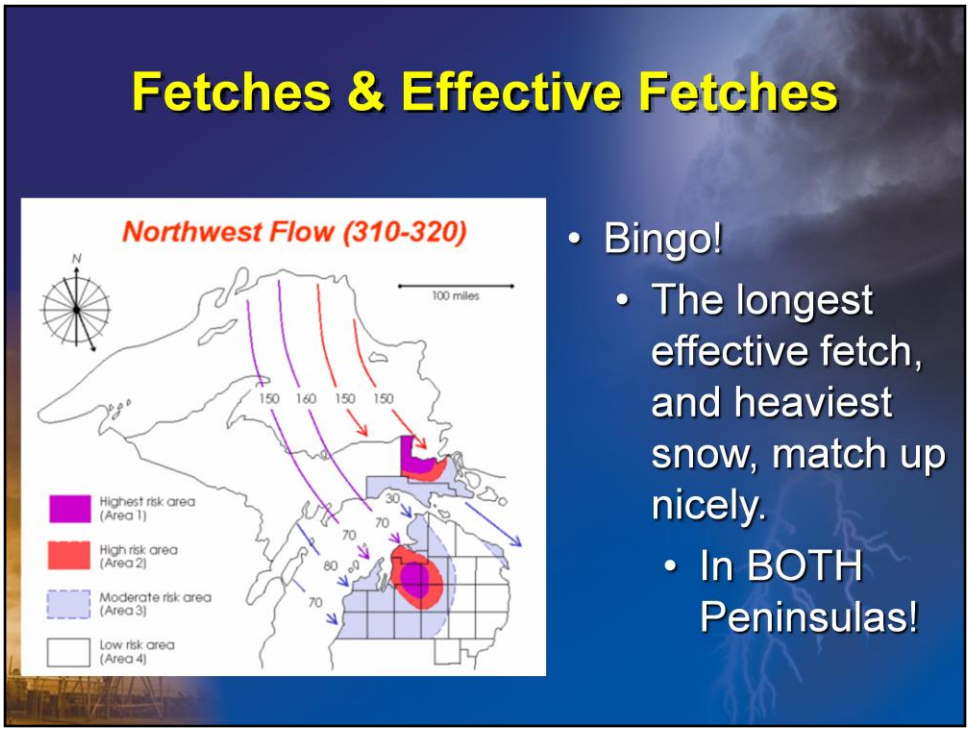
Fetches & Effective Fetches

- Yes - there's another lake up there!
- An airmass will retain "lake effect characteristics" on a *short* trip over land, IF there is little terrain (hills/mountains) to cross
- If this is the case, the result is a longer "effective fetch" due to the air crossing multiple lakes

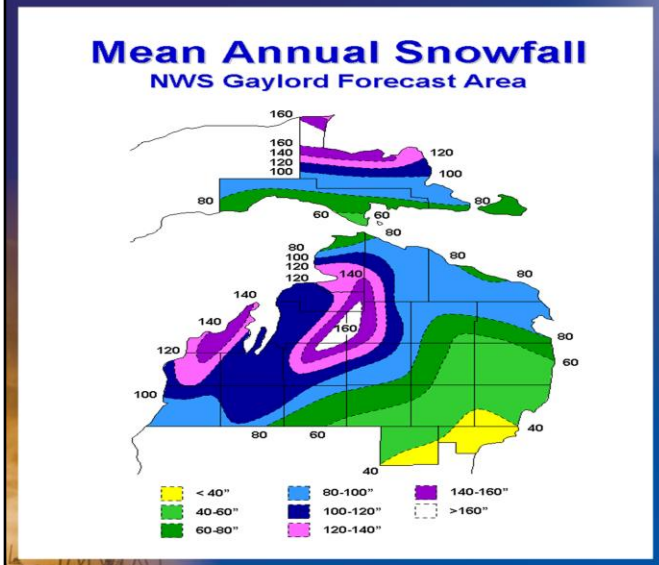
Fetches & Effective Fetches



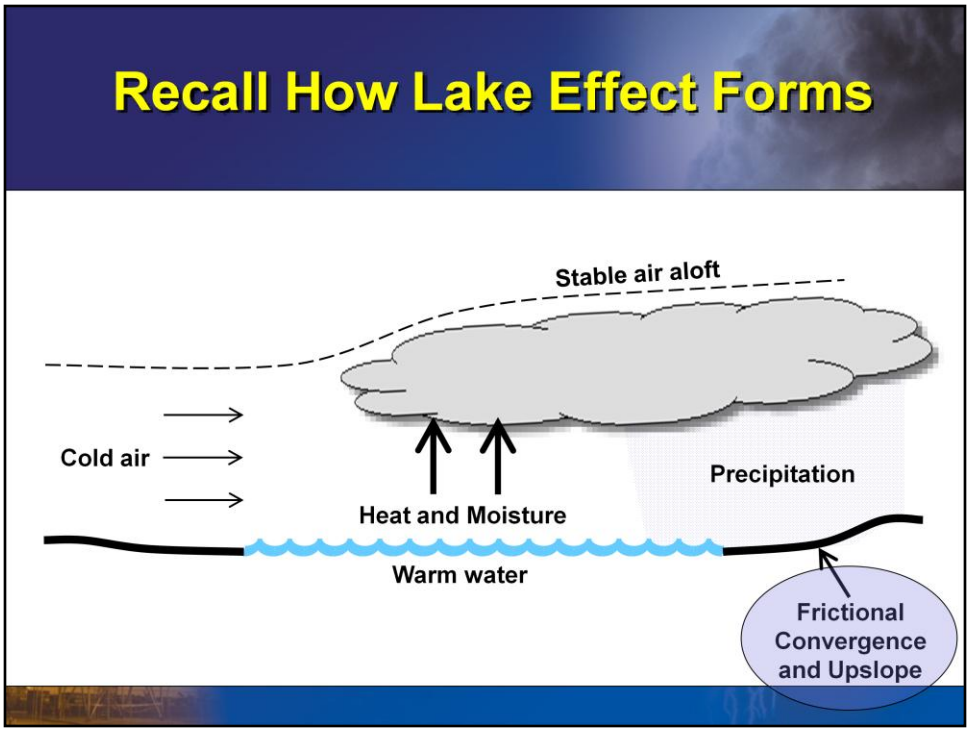
- As it turns out, the east half of the U.P. is narrow, and does not have many hills
- The west half is “thicker” and much hillier, and eliminates a Lake Superior contribution to an effective fetch



This map shows the total effective fetch when the effects of BOTH lakes are put together. Now, you see a much better correlation between fetch and mean annual snowfall amount. Flow is curved due to the what is in many cases low pressure exiting the region to the north and east.

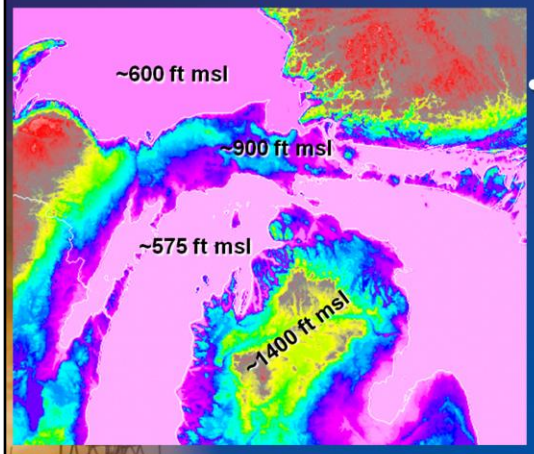


- But why is the heaviest snow <u>inland</u>?
  - It's lake effect; shouldn't it be near the lake?

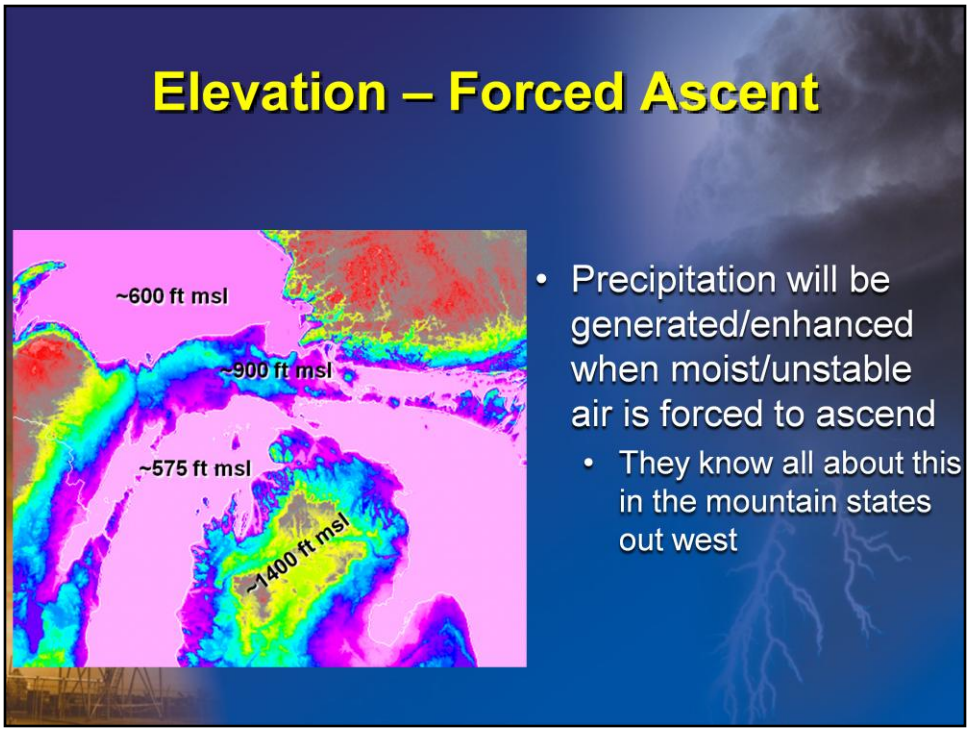


Recall how lake effect snow forms. Cold air, moving over the relatively warm lake waters is heated and moistened from below. When this warm/moist air reaches the downwind shoreline there is both 1) frictional convergence at the coast and 2) upslope flow over the downstream landmass. The amount of precipitation that falls from the lake induced snow-band will be related to just how much topography this air must rise over.

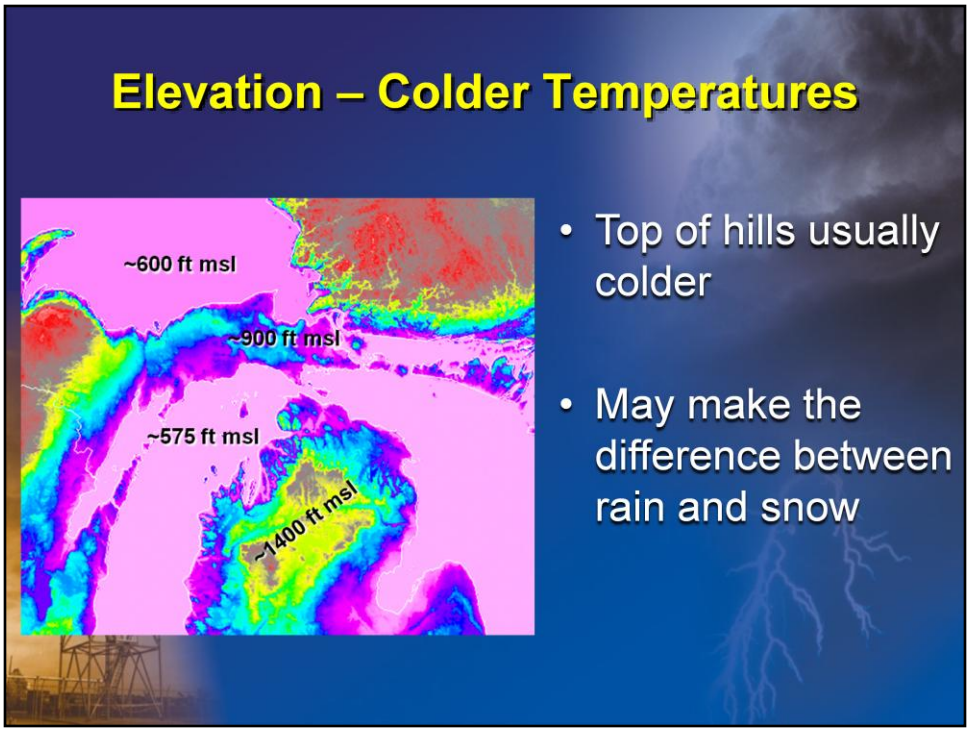
Elevation



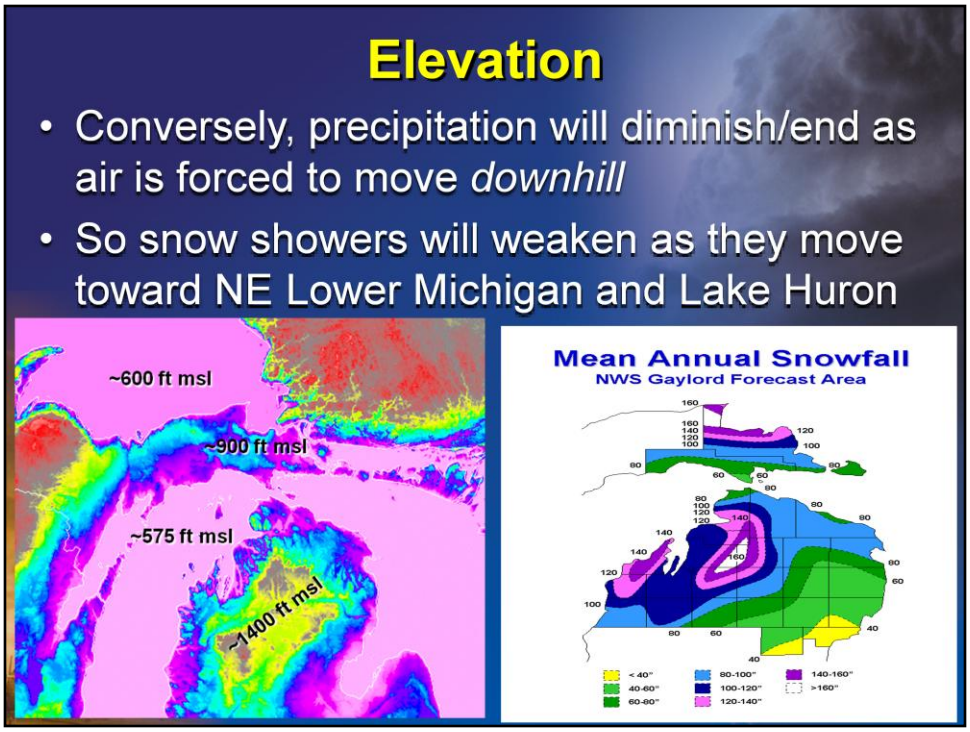
- Elevation plays 2 key roles
  - Forced Ascent
  - Colder Temperatures



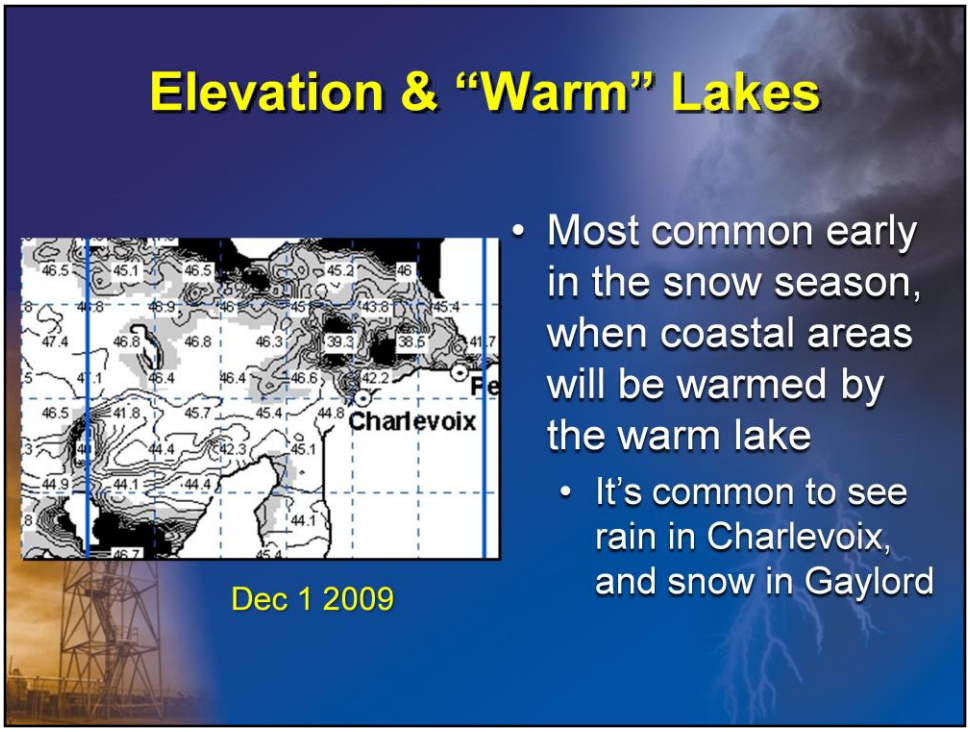
Our terrain isn't anywhere near as dramatic as out west, BUT our low level airmass is almost always moist and unstable in the late fall/winter, so we get terrain enhancement very frequently.



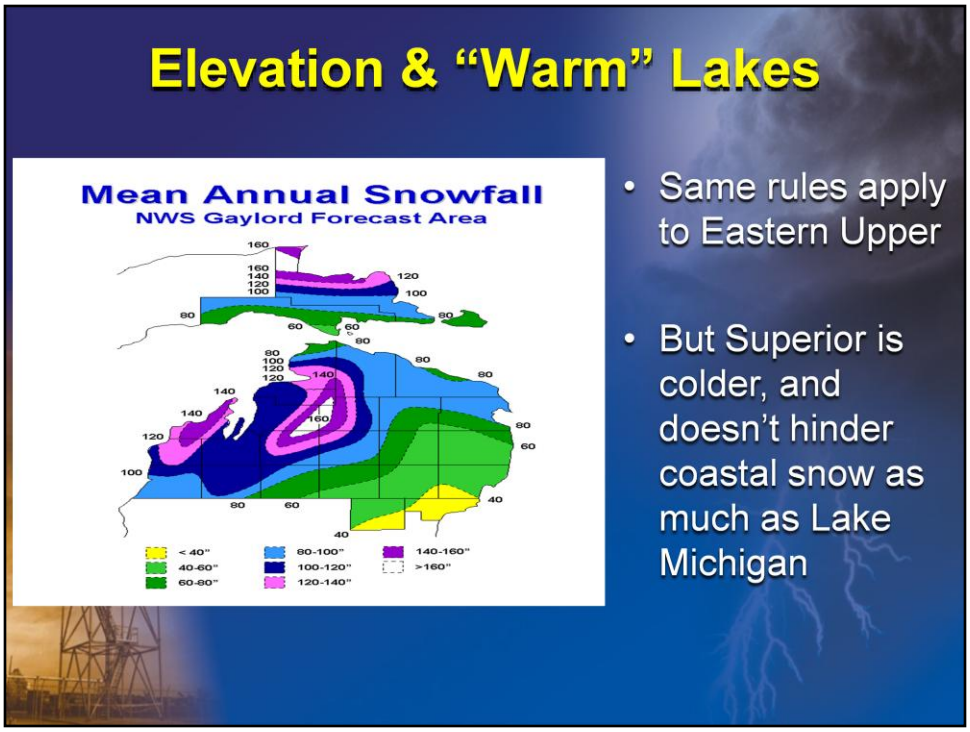
Or, it can make the difference between slushy snow that accumulates poorly (or plain rain), and a drier snow that piles up better.



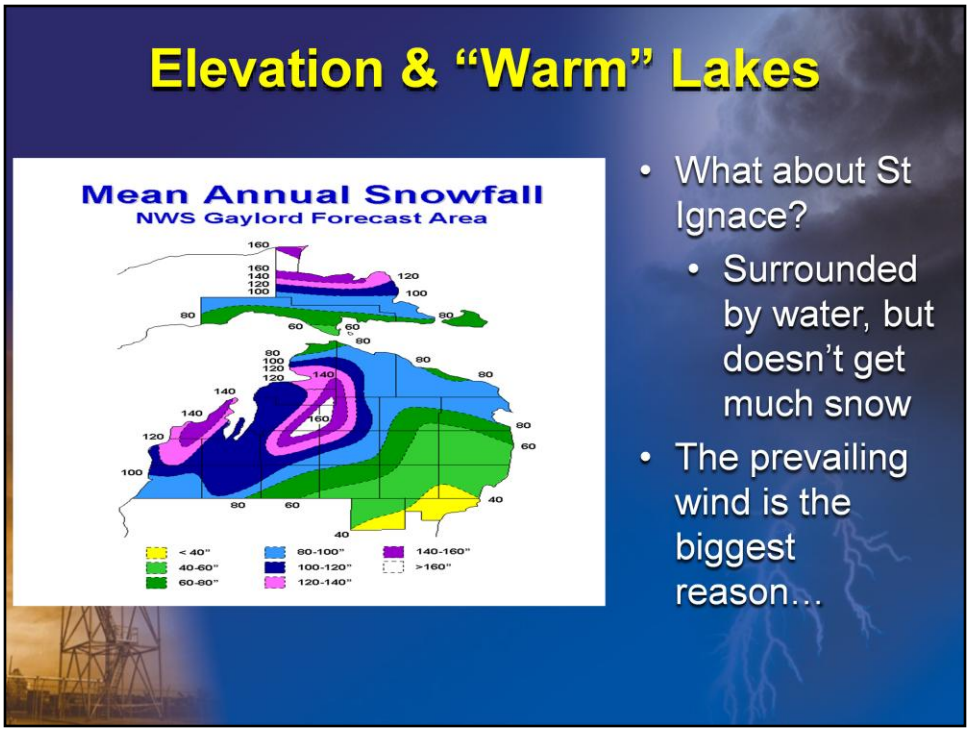
This is why areas such as Gladwin and Arenac counties do not see much if any lake effect snowfall.



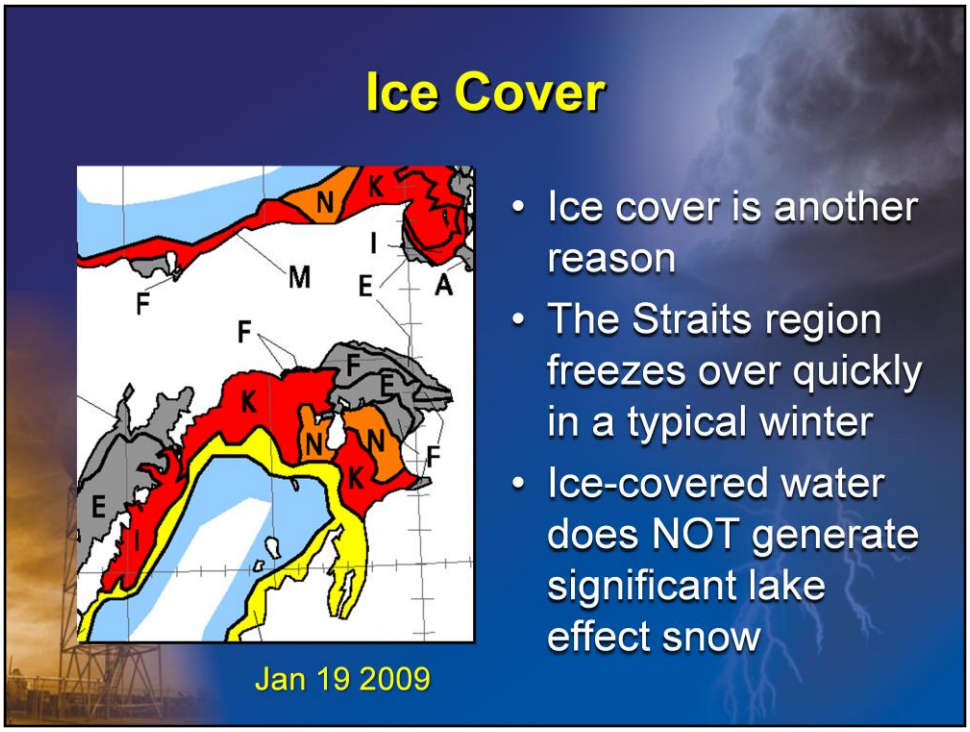
The lakes cool down more slowly than the land mass during the fall. In many cases, this yields a "lake-modified" airmass with warmer temperatures near the lake shore versus inland.



Note that the impact isn't as great over Eastern Upper Michigan as Lake Superior is almost always colder than Lake Michigan.



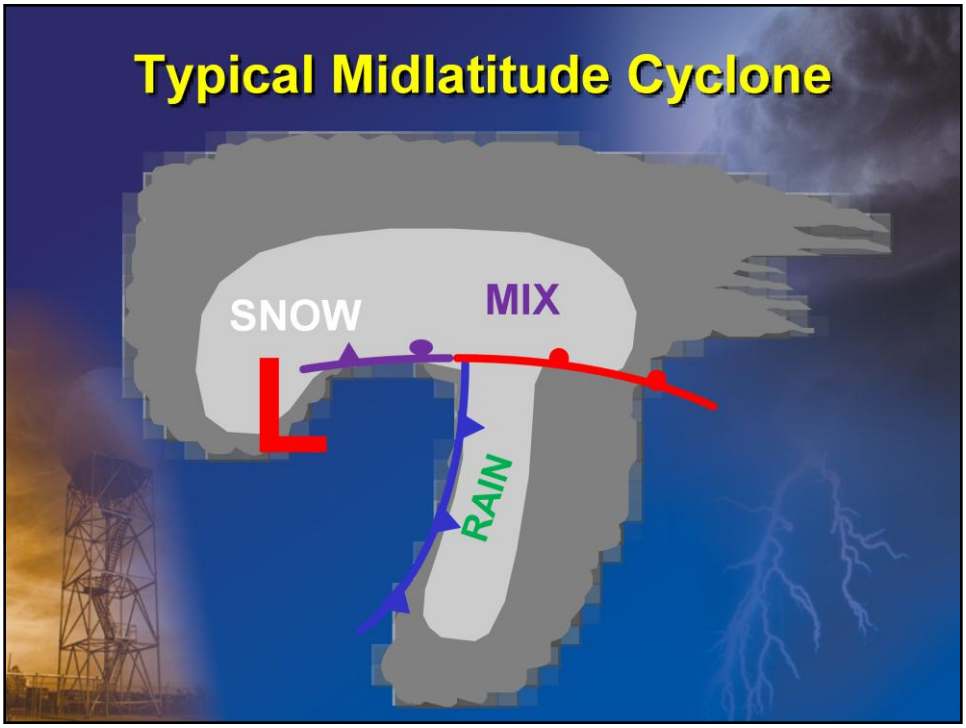
Why is St. Ignace in a relative minimum for mean annual snowfall? There are two reasons. First, is the prevailing wind direction and amount of upstream land that any lake effect precipitation must move over. Second is…



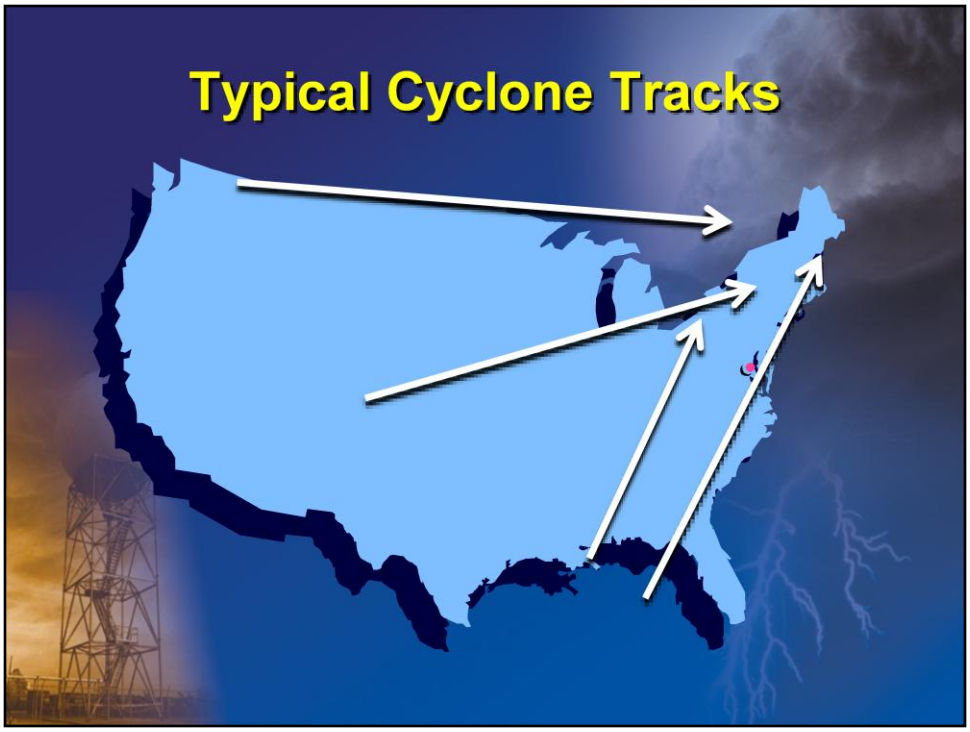
Put another way, the fetches in the Straits area are reduced as ice cover develops and grows.

The Home Stretch…

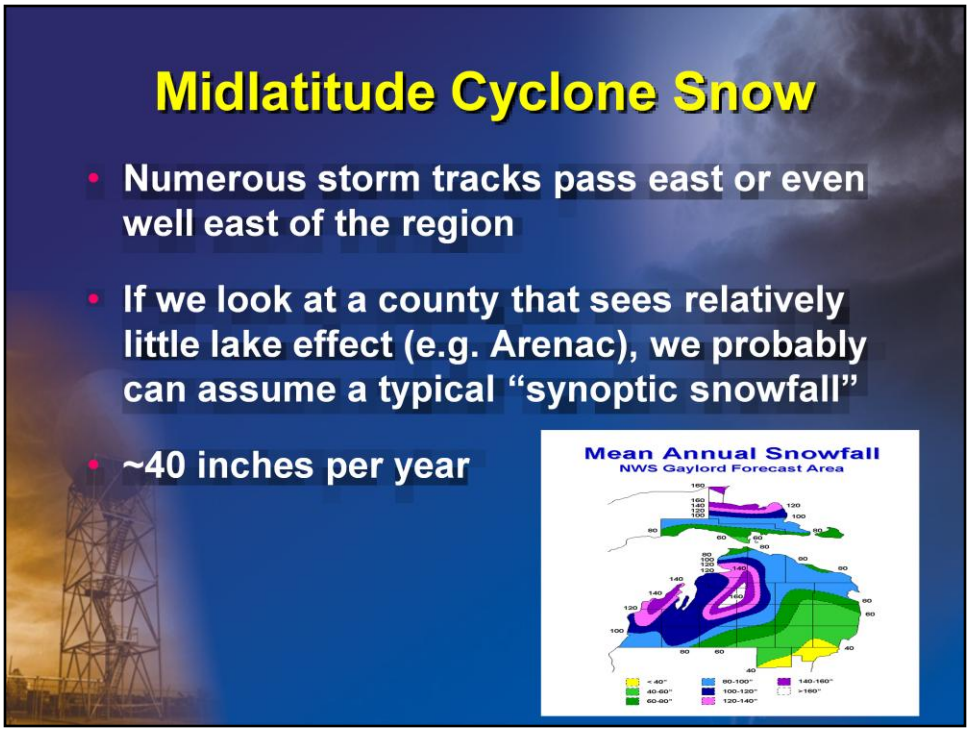
- Okay, we now have a handle on lake effect snow and its distribution
- But, what about snow that doesn't originate from the lakes?



Here is a typical midlatitude cyclone with the primary area of snowfall occurring near and to the north/northwest of the surface cyclone. While rain is seen south of the warm front in the "warm sector", a wintry mix of precipitation is typically seen north of the warm front.

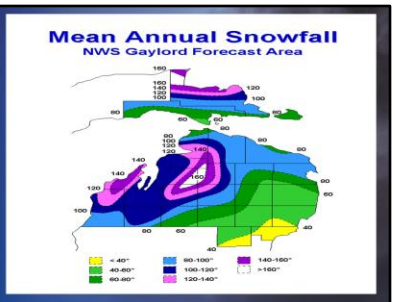


This map shows typical midlatitude cyclone tracks across the continental United States. There is the Alberta Clipper (farthest north), the Colorado Low, and the east coast Nor'easter.



Interestingly, many of these storm tracks miss our region to the east, which suggests that if it were not for lake effect snow, we would see less snowfall than many areas over the northeastern United States (which is closer to this storm track). A typical amount of "synoptic" or "system" snow can be seen in Gladwin/Arenac counties (as these areas do not see significant lake effect snow). The amount is about 40" per year.

In Summary



- Our snow comes from two sources
  - *Lake Effect*
  - *Mid latitude cyclones*
- Lake Effect depends on numerous microscale factors
  - *Fetch/effective fetch, elevation, lake temperature, ice cover, distance to shore, etc.*


Any Questions???